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ABSTRACT

Criteria are briefly proposed for final conclusions, research problems, and research hypotheses in quantitative research. Moreover, based on a proposed definition of applied and basic/general research, it is argued that (1) in applied quantitative research, while research problems are necessary, research hypotheses are unjustified, and that (2) in basic/general quantitative hypothesis-testing research, research hypotheses are sufficient, while research problems are unjustified. These arguments are partly related to the distinction between taking knowledge for granted and regarding knowledge as being on trial. The paper illustrates the central role played by the study's general aim and its relation to existing knowledge in the research domain.

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In the methodological literature about the quantitative approach in education and psychology, research problems and hypotheses are considered central elements in research (Bordens & Abbot, 2018; Campbell et al., 1982; Coolican, 2014; Cozby & Bates, 2018; Gall et al., 1996; Judd et al., 1991; Kerlinger, 1986; Medawar, 1979; Polit & Beck, 2004; Robson, 1993). As stated by Gall et al. (1996, p. 47): "The imagination and insight that goes into defining the research problem usually determines the ultimate value of a research study more than any other factor." Research problems and hypotheses are important means for attaining valuable knowledge. They are pointers or guides to such knowledge, or as formulated by Kerlinger (1986, p. 19): " … they direct investigation." There are many kinds of problems and hypotheses, and they may play various roles in knowledge construction. For example, they vary with respect to whether or not they are related to theory, and to whether they are causal or descriptive (non-causal).

According to this literature, a research problem will often be followed by (at least) one research hypothesis. The problem is considered broader than its hypothesis in the sense that the problem has several possible solutions/answers, while the hypothesis corresponds to one or some of the possible solutions.

The primary purpose of the present paper is to discuss whether a research problem and a research hypothesis are both justified in a quantitative study, i.e., is a hypothesis justified if a problem has been formulated, and is a problem justified if a hypothesis has been formulated?

Criteria for choice of research problems and hypotheses, criteria for the final conclusion, and the relations between these criteria are somewhat inadequately accounted for in the literature, e.g., in the literature referred to above. A secondary purpose of the paper is to present briefly a more coherent and adequate description.

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The two purposes are dealt with in the two sections below. Since the discussion related to the primary purpose depends partly on the treatment of the other purpose, the secondary purpose is dealt with in the first section. For simplicity, the terms “research problem” and “research hypothesis” will often be replaced by the shorter terms “problem” and “hypothesis,” respectively.

The account is limited to individual, substantive, empirical, and quantitative research studies in education, psychology, and related disciplines. The philosophical frame of critical realism is supposed, i.e., it is assumed that an external reality exists, though it can never be known perfectly by observers (Cook & Campbell, 1979, ch. 1). Both a problem and a hypothesis are therefore related to some external reality: the former is a question about some reality, the latter an expected or predicted knowledge claim about some reality.

Briefly About Criteria for Final Conclusions, Problems, and Hypotheses

The fundamental purpose of substantive research may be considered that of producing valid and needed knowledge in specified domains, or as formulated by Polit and Beck (2004, p. 3): “The ultimate goal of research is to develop, refine, and expand a body of knowledge.” This knowledge may be of various kinds, e.g., be in terms of theories.

The set of substantive and methodological knowledge in a domain is hereafter termed *knowledge space* (Lund, 2013). This knowledge space can be divided into two subsets: the substantive subspace and the methodological subspace. The substantive subspace—which is focused on here—includes knowledge claims produced by substantive research. The methodological subspace is a set of methodological principles, methods, and scientific criteria, e.g., validity systems, where only some of these elements are included in a research study. This subspace contains knowledge produced by methodological research, and is used as a means in substantive research for producing knowledge claims.

The above-mentioned fundamental purpose of substantive research can be reformulated as that of changing parts of the substantive knowledge space so as to attain valid and needed knowledge.

Transfer of a final produced knowledge claim to knowledge space requires that this produced claim satisfies certain criteria. Such criteria—here termed *basic* criteria—are proposed below. In addition, criteria concerning the choice of research problems and hypotheses are proposed.

Two basic criteria for produced knowledge claims follow directly from the fundamental purpose of research, here termed the *validity* criterion and the *need* criterion. Each criterion varies with respect to its satisfaction, and a produced knowledge claim should satisfy both criteria to at least a moderately high degree. The criteria are meant to apply to both exploratory and hypothesis-testing research as well as to applied and basic research.

Validity concerns the truth of knowledge claims (Cook & Campbell, 1979; Cronbach, 1982; Shadish et al., 2002). A knowledge claim is valid to the extent we can be sure it is true about some external reality. Validity is therefore a property of such a claim, not of methods, analyses, or results. The knowledge may be a composite, e.g., in the form of a complex theory, and validity corresponds then to the overall truth of the composite. (The concept of validity is also included in the second need subcriterion below.)

The need of a produced knowledge claim is here defined as a combination of its importance and its representation of new knowledge. Accordingly, the need criterion for a produced claim consists of two subcriteria: (1) the produced claim should represent an important part of knowledge space, and (2) the produced claim should represent a considerable degree of new knowledge, i.e., should represent a considerable improvement in knowledge status of that part from before the study to after the study.

Hence, the first subcriterion concerns the claim’s importance, which will be the same before and after, whereas the second subcriterion concerns a change in knowledge status. The change in knowledge status in the second subcriterion may consist in that the study has produced a completely or partly new claim, or in that the validity of a pre-existing claim has been changed by the study, as in hypothesis testing. The validity concept is therefore here a special case of the knowledge-status concept. Satisfaction of the need criterion requires that both subcriteria are at least moderately satisfied, and in this case, the study has produced needed knowledge. If only one of the two subcriteria are satisfied—e.g., the study has resulted in a new but unimportant knowledge, or in an important but already known knowledge—the study has not given needed knowledge. Note that the evaluation of the second subcriterion requires a comparison of the before-study and after-study knowledge spaces.

The account above concerns produced knowledge claims. One central task in empirical research is how to select research problems and hypotheses. Choice of research problems should be based on three criteria, termed the *researchability* criterion, the *initial-need* criterion, and the *feasibility* criterion.

The researchability criterion (Polit & Beck, 2004, pp. 70–71) requires that the problem can be solved by scientific methods. Problems of moral nature or social problems cannot be directly researched. This criterion requires that a research problem should be formulated precisely, or according to Kerlinger (1986, p. 17): " … the problem should be stated clearly and unambiguously in question form … ."

By the initial-need criterion is here meant that a research problem should refer to a part of the before-study knowledge space which (1) is important, and (2) is insufficiently investigated. Hence, this criterion consists of two subcriteria. The second subcriterion implies that the initial knowledge status of the chosen part should not be extremely high. Satisfaction of these two subcriteria means that there is a need for further research. The selection of a research problem in accordance with the initial-need criterion should be based on need analysis of the before-study knowledge space (and also of the practical context in an applied study; see later.)

The feasibility criterion (Polit & Beck, 2004, pp. 70–73) requires that resources are available for solving a research problem, e.g., satisfactory samples of persons and other construct indicators, adequate design and analysis, necessary time, material resources, sufficient competence in the research team, and ethical possibilities. A research problem can be broadly or narrowly formulated, and a broad problem will in general require more resources.

Note that the first initial-need subcriterion equals the first need subcriterion for produced knowledge claims, that the second initial-need subcriterion refers to the before-study knowledge space, and that the second need subcriterion for produced claims refers to the change from the before-study space to the after-study knowledge space. Observe further that the feasibility criterion is related to the methodological knowledge subspace. The selection of necessary resources in a study, e.g., appropriate design, depends on knowledge in this subspace, and illustrates therefore how the methodological subspace is used as a means in substantive research. The three points below should also be considered.

First, a trade-off between the initial-need criterion and the feasibility criterion can often occur in that a promising research problem cannot be satisfactorily solved due to lack of resources. If necessary resources are not available at the start of the study or during the research process, the research problem should be revised or substituted by another one in accordance with the three criteria.

Second, the satisfaction of the second initial-need subcriterion and the feasibility criterion can have consequences for the two basic criteria for produced claims. If the initial knowledge status is extremely high, the knowledge status cannot be improved, the second need subcriterion for produced claims can therefore not be satisfied, and starting a research study would then be meaningless. Why investigate "something" when we already have the needed knowledge? As for the feasibility criterion, the more and better resources included in the study, the better quality of the study implementation, which increases the probability of attaining adequate validity of the final produced claims.

Third, factors such as personal interest, curiosity, and luck will play a role in the selection of research problems (Campbell et al., 1982), but such factors cannot be regarded as criteria. The choice of a problem must be based on general criteria, such as the three ones proposed here.

As for the choice of research hypotheses, the three preceding criteria for research problems apply also here, except for that the criteria now refer to hypotheses instead of problems. Hence, a hypothesis should be researchable, should refer to an important and insufficiently investigated part of the before-study knowledge space, and necessary resources should be available for testing the hypothesis. Since a hypothesis is a knowledge claim, the validity concept applies here. A hypothesis should therefore also satisfy a *validity* criterion, and this criterion requires that the initial validity of a hypothesis should be of moderate size, i.e., neither too low nor too high. If the validity is extremely low, there is no argument for formulating a hypothesis at all, whereas an extremely high validity will be in conflict with the subcriterion that the hypothesis should refer to an insufficiently investigated part of knowledge space. Why bother to test a hypothesis when we assume it is true? The initial validity of a hypothesis is determined by need analysis of the before-study knowledge space.

A falsified hypothesis in hypothesis-testing research is regarded here as a produced knowledge claim, and hence as included in knowledge space. Such a produced claim broadens knowledge space in the same manner as a verified/confirmed hypothesis. All kinds of valuable research will therefore make the knowledge space more comprehensive, never smaller.

Note that because validity refers to the truth of a claim about some reality, because a hypothesis is such a claim, and because a problem is a question instead of a claim, the validity concept applies to hypotheses, not to problems. It should be added that the choice of problems and hypotheses should be based not only on the proposed criteria but also on the general aim of the study, as illustrated in the next main section.

Justification of Research Problems and Hypotheses

In the methodological literature in education, psychology, and related disciplines, it is often assumed that quantitative research studies should include both research problems and hypotheses (Bordens & Abbot, 2018; Gall et al., 1996; Judd et al., 1991; Kerlinger, 1986; Polit & Beck, 2004; Robson, 1993). The following quotations from the well-known and authoritative book of Kerlinger (1986) can be considered representative of points of view in such literature.

> The third criterion is often difficult to satisfy. It demands that the problem and the problem statement should be such as to *imply* possibilities of empirical testing. A problem that does not contain implications for testing its stated relation or relations is not a scientific problem. (p. 17)
>
> Just as important as hypotheses are the problems behind the hypotheses. As Dewey has well pointed out, research usually starts with a problem. (p. 19)
>
> Problems and hypotheses, then, have important virtues. One, they direct investigation. The relations expressed in the hypotheses tell the investigator, in effect, what to do. Two, problems and hypotheses, because they are ordinarily generalized relational statements, enable the researcher to deduce specific empirical manifestations implied by the problems and hypotheses … There are important differences between problems and hypotheses. Hypotheses, if properly stated, can be tested. While a given hypothesis may be too broad to be tested directly, if it is a "good" hypothesis, then other testable hypotheses can be deduced from it. Facts or variables are not tested as such. The relation stated by the hypotheses are tested. And a problem cannot be scientifically solved unless it is reduced to hypothesis form, because a problem is a question, usually of a broad nature, and is not directly testable. One does not test the questions: Does efficiency enhance organizational effectiveness and profitability? Does differential experience modify the brain? One tests one or more hypotheses implied by the questions. (p.19)

Hence, according to the quotations above, whereas both a research problem and a hypothesis are important in a quantitative research study, a problem cannot be scientifically solved unless it is reduced to hypothesis form.

Below some important issues related to the roles played by research problems and hypotheses in quantitative research will be presented and discussed, including the assertions of Kerlinger. For example: Is a research hypothesis justified if a research problem has been formulated? Is a research problem justified if a research hypothesis has been formulated? The account is limited to individual, substantive, empirical, and quantitative research studies.

Applied and basic/general research differ with respect to general aim. As defined here, whereas the aim in applied research is to generate knowledge to be used directly in specified professional/practical work or contexts, basic/general research is meant to develop theoretical knowledge or other kinds of general knowledge. The discussion below is related to this difference in general aim, and the account is therefore given for applied and basic/general research separately. The discussion is also related to the distinction between taking knowledge for granted and regarding knowledge as being on trial. The account holds for both simple and complex research (Polit & Beck, 2004), for alternative definitions of causality (Cook & Campbell, 1979; Lund, 1991; Shadish et al., 2002), and for descriptive (non-causal) research. Issues dealt with in the two following subsections will be further elaborated in the third subsection.

Applied Research

The account in this subsection is limited to simple research problems and hypotheses. The case where the study includes a research problem, but not a research hypothesis, is discussed first, followed by an analysis of the case where a hypothesis is added to the problem and tested. Hence, the first case represents exploratory research, and the second case hypothesis-testing research.

One perspective on exploratory research proposed here is (a) that to each research problem corresponds a set of possible solutions of the problem, i.e., possible final conclusions, (b) that when a problem is chosen, the researcher will or should also reflect on which possible solutions exist, and (c) that the methodological strategy is planned and implemented so as to find the best candidate within the set of possible solutions. Each possible solution can be considered a knowledge claim, and it will have an initial validity degree as a function of relevant information in the before-study knowledge space. The possible solutions in the set may vary with respect to initial validity. These validities should ordinarily be thought of as tentative, approximate quantities, due to somewhat unclear knowledge-space information.

The preceding account can be illustrated and elaborated by the following artificial study: Suppose that cognitive therapy is a well-established and costly treatment for young alcoholics, and that need analysis of the therapeutical context and the knowledge space shows that knowledge of the therapy effect on alcohol drinking, in this case, is clearly needed. The general aim of a planned study is therefore to find the therapy effect for such adolescents. Based on this general aim and on the three criteria for problem choice, the following simple research problem is chosen: "Which effect does cognitive therapy have on alcohol drinking for young alcoholics in a clinical setting?". A large and representative sample of young alcoholics is used in a of pretest-posttest design, i.e., with one therapy condition and no control conditions, and with measurements of alcohol drinking at pretest and posttest, as well as at two occasions before pretest (Shadish et al., 2002). Statistical analysis and interpretation lead to the final result conclusion: "Cognitive therapy has a moderate positive effect on alcohol drinking for young alcoholics in a clinical setting." (By a positive effect is meant a reduction of drinking.) In order to generalize the study results satisfactorily to the established therapeutical context, the study context has been planned and implemented so similar to the therapeutical context as possible.

The sketched study—here termed the *original study*—can be characterized as ordinary and simple quantitative applied research, as a kind of evaluation research. Since a research hypothesis is not included, the study can also be considered exploratory research.

To the given simple research problem corresponds a set of possible solutions, and this set is related to the set of possible effect sizes. Since alcohol drinking is a quantitative variable, a very large set of effect sizes (an infinite set, in principle) may be imagined. However, a coarse classification of effect sizes into broad categories will be sufficient, e.g., extremely high positive effect, high positive effect, moderate positive effect, small positive effect, no effect, small negative effect, and so on. Let us suppose that the set of possible solutions in our case is related to this coarse classification. The mentioned actual final conclusion can then be regarded as representing one element in this set, and as an estimate of the best candidate within the set of possible solutions.

As for validity, the following two points should be considered: (1) Since each possible solution is a knowledge claim, it has a (tentative) initial validity as a function of relevant information in the before-study knowledge space. The possible solutions may vary with respect to validity, because earlier similar research—e.g., research concerning cognitive therapy for adult alcoholics—will suggest that some solutions are more probable than other ones. For simplicity, it is supposed here that one of the solutions has the clearly highest initial validity in the set, and this possible solution is symbolized as ps_{max}. Note that this validity cannot be extremely high, because such an extreme validity would violate the second initial-need criterion for the choice of a research problem. (Why should we choose a problem if we know its answer?) (2) The validity of the actual final conclusion above is a function of the methodological quality of the sketched study, including the quality of the pretest-posttest design used here, as well as a function of relevant before-study knowledge-space information via $\mathrm{ps}_{\mathrm{max}}$. If the final conclusion is in line with the information, i.e., if the final conclusion is in line with $\mathrm{ps}_{\mathrm{max}}$, the validity of the final conclusion will be strengthened, and vice versa. Hence, this knowledge-space information via $\mathrm{ps}_{\mathrm{max}}$ is here taken for granted and will affect the conclusion's validity.

If our final conclusion satisfies the two basic criteria of validity and need, it can be transferred to the after-study knowledge space. In this case, the study can therefore be considered valuable since it has changed the knowledge space in an important way and has provided findings of direct relevance to professional work.

Suppose now that a research hypothesis to be tested is added to the given research problem with its coarse set of possible solutions, while keeping general aim and methods unchanged. The resulting study is here termed the *extended* study. This hypothesis is assumed to satisfy the above-mentioned criteria for the selection of a hypothesis. As for the validity criterion, the validity should be neither too low nor too high, and the hypothesis should be equal to $\mathrm{ps}_{\mathrm{max}}$. The critical question is which consequences this added hypothesis will have.

The added hypothesis changes the study from exploratory to hypothesis-testing research, since the hypothesis is regarded as being on trial. Accordingly, whereas the final conclusion in the original study contains one conclusion, the final conclusion in the extended study can be regarded as consisting of two conclusions: (1) the conclusion concerning the measured effect, and (2) the conclusion concerning the final-evaluated validity of the hypothesis. Since the extended study represents hypothesis-testing research, the (2)-conclusion is the central one, while the (1)-conclusion and its validity are necessary but subordinate means for the (2)-conclusion. If the (1)-conclusion is in line with the hypothesis, the validity of the hypothesis is strengthened, and vice versa. Hence, in the extended study, the hypothesis is used for predicting the (1)-conclusion, and the success or failure of this prediction will affect the hypothesis' validity. Note that the (2)-conclusion requires that the validity of the (1)-conclusion is satisfactory. Unsatisfactory validity implies that the hypothesis can neither be considered supported nor unsupported.

It follows that while the hypothesis and its validity are central in the extended study, the final result conclusion and its validity are central in the original study. Note further that since the addition of the hypothesis cannot lead to a new measured causal effect, the (1)-conclusion in this extended study is identical to the final conclusion about the causal effect in the original study.

The logical analysis of the sketched original and extended studies above leads to the following three important points: First, Kerlinger's (1986, p. 19) assertion that "a problem cannot be scientifically solved unless it is reduced to hypothesis form … " is not correct here. As shown above, the combination of the final conclusion and its validity in the original study is a solution of the problem, where the validity is a function of the study's methodological quality and relevant knowledge-space information. Hence, the precise problem in the study can be scientifically solved, provided that the final conclusion satisfies the two basic criteria of validity and need. Second, an important argument against the extended study is that this study will be in conflict with the given general aim. We are interested in finding the therapy effect—in choosing the best candidate within the set of possible solutions—not in testing a hypothesis related to one of these solutions. Adding a hypothesis to the original study is therefore unjustified. Third, a ps_{max} is supposed above. If the set of possible solutions had not included a ps_{max}, there would be no argument for formulating a research hypothesis at all. The given research problem, on the other hand, would still be appropriate, but the validity of its related final conclusion would then be only a function of the study's methodological quality.

In the therapy studies above, it is assumed that the cognitive therapy is a well-established treatment for the specified population. A randomized experimental design will be problematic in this case, due to possible atypical control-group behavior (Shadish et al., 2002). Suppose instead that this therapy is a new treatment for this population, and that a randomized design with one control-group is implemented. Let us assume that the need-analysis results, the general aim, the research problem, the set of possible solutions, the person sample, and the setting are the same as before. The final result conclusion and its validity may differ from the original study, but as before an added hypothesis is unjustified.

The studies above are causal ones (e.g., Cook & Campbell, 1979; Lund, 1991; Shadish et al., 2002). Suppose, as another artificial illustration, the following outline of a simple descriptive (non-causal) study. Alcohol drinking among adolescents in a given population is a serious social problem. Before an information campaign with focus on this social problem is implemented, some background data are required. Need analysis of the social problem and knowledge space shows that it is necessary to obtain knowledge about gender in alcohol drinking, because such differences will have direct consequences for the extent and content of the campaign. Accordingly, the general aim of a planned study is to provide such knowledge, and one simple descriptive research problem is: "Is there any average difference in alcohol drinking between boys and girls in the population; and if so, what is the direction and size of the difference?" A survey based on a large and representative sample of adolescents results in the final conclusion: "Boys drink considerably more than girls."

A logical analysis of this sketched descriptive study concerning gender differences in drinking habits will be parallel to the analysis of the original therapy study above. In short: (1) To the given descriptive problem corresponds a set of possible solutions related to a coarse classification of the quantitative drinking variable, and the final conclusion is one element in this set. The general aim of the study is to estimate the best candidate of this set. (2) The final conclusion is considered an estimate of the best candidate. The validity of this conclusion is a function of the study's methodological quality and possible relevant information in the before-study knowledge space. If the conclusion satisfies the two basic criteria of validity and need, it is an adequate solution of the research problem. (3) Adding a hypothesis to the descriptive study will be in conflict with the general aim, since we are not interested in testing a hypothesis related to one of the solutions in the set. The addition of a hypothesis is therefore unjustified.

Basic/General Research

In basic/general research the focus is on the development of theoretical/general knowledge, and both testing and exploratory strategies are relevant. The common case where a theory or hypothesis is tested is treated below, whereas exploratory strategies are not relevant for the issues discussed here. In order to better compare this theory/hypothesis-testing approach with the preceding account of applied research, an enlargement of our therapy example is used for illustration.

Suppose we want to test a theory in knowledge space that cognitive therapy has an impact on various kinds of dependence, i.e., dependence of alcohol, narcotics, hyper-sexuality, internet, games, and so on. The theory includes a process rationale for how the therapy affects the dependences. Several hypotheses can be derived from this complex theory, at least one hypothesis for each dependence. The theory cannot be tested directly, but indirectly by testing the hypotheses in relevant therapy studies. For simplicity, suppose that each study contains only one hypothesis and one dependent variable. The earlier extended study with young alcoholics may illustrate one of these studies, provided that the general aim in the study is reformulated so it now refers to a test of the complex theory, that the research problem is omitted, and that the included hypothesis now is considered derived from this theory. The methods and results in this study—here termed the *reformulated* study—are the same as in the extended study.

The final conclusion in each study—such as our reformulated study—can be regarded as consisting of three conclusions: (1) The conclusion concerning the measured effect, (2) the conclusion concerning the validity of the derived hypothesis, and (3) the conclusion concerning the validity of the theory. Since the general aim is to test the theory, the (3)-conclusion is the central one, whereas the two other conclusions are necessary but subordinate means for the (3)-conclusion. The validity of the theory is increased (reduced) if the validity of the hypothesis is increased (reduced), and the hypothesis' validity depends, in turn, on the (1)-conclusion and its validity. Hence, each therapy study involves two tests, one direct test of the hypothesis and one indirect test of the theory. Note further that this increased or reduced validity of the theory depends on how broad the theory is. The broader the theory, the lesser such validity "contributions" tend to be, and more studies are needed. Since our theory is of considerable breadth, a satisfactory test of the theory will require several studies. Note also that this testing of theory and hypothesis requires satisfactory validity of the (1)-conclusion.

Let us now analyse the reformulated study and compare it with the earlier extended and original therapy studies. The following points are important.

First, both the theory and its hypothesis in the reformulated study have to satisfy the above-mentioned four criteria for hypothesis selection, i.e., the researchability, initial-need, feasibility, and validity criteria. Need analysis of the before-study knowledge space will provide the relevant information concerning the three latter criteria.

Second, whereas a hypothesis in the extended study is unjustified, the hypothesis in the reformulated study is necessary because it is logically related to the theory. Since the theory is on trial, also the hypothesis will be on trial.

Third, whereas a research problem is necessary in the original study, it is unjustified in the reformulated study. This difference is a consequence of that the general aim in the former study is to find the best candidate among the possible solutions, while the general aim is to test the theory in the latter study. The latter general aim can be used instead of a research problem in the reformulated study, and can be stated as: "The purpose of this study is to test the theory … ." As for the derived hypothesis, since the aim here is to test the hypothesis in order to test the theory, a research problem related to this hypothesis is not justified.

Fourth, the effect size in the reformulated study equals the effect size in the original study, which illustrates how results in basic research sometimes can have relevance for practical work.

The illustration above involves a theory-based hypothesis, but basic/general research—as defined here—includes also hypotheses not based on theory, e.g., the well-known frustration-aggression hypothesis where frustration is a determinant of aggression (Berkowitz, 1989). This hypothesis can be considered a general one, encompassing many kinds of frustration, aggression, persons, and contexts. If we intend to test this general hypothesis, several studies are therefore required. The conceptualization and evaluation of each study will be similar to the account of the above example. For instance, each study includes (a) the general hypothesis and (at least) one specific derived hypothesis, (b) an indirect test of the general hypothesis and a direct test of the specific hypothesis, and (c) use of general aim instead of an unjustified research problem. The studies may sometimes provide results of practical relevance.

Concluding Remarks

Choice of research problems and hypotheses is related to the proposed distinction between basic/general and applied research. As defined here, the general aim in basic/general research is to produce theoretical/general knowledge, whereas the aim in applied research is to generate knowledge to be used directly in specified professional/practical contexts. Note that the present account is limited to individual, substantive, empirical, and quantitative research studies.

Basic/general research encompasses not only research with a focus on theoretical knowledge but also research which aims at other kinds of general knowledge, such as the general frustration-aggression hypothesis. The distinction between a theory and a general hypothesis may be considered somewhat vague and arbitrary. Testing of a general hypothesis should therefore be conceptualized in the same way as testing of a theory. That is, a specific hypothesis is derived from the general hypothesis and tested as part of the test of the general hypothesis. Basic/general research can sometimes provide results of relevance to practical contexts, as illustrated above, and also provide information in the form of principles or "understandings" related to processes or states in such contexts (Mook, 1983). Such research includes also exploratory strategies, but the account here is limited to the theory/hypothesis-testing approach.

If the focus is on testing a theory/general hypothesis, a research problem is unjustified, and can be considered replaced by the general aim of the study. General, vague problems—such as the two questions in Kerlinger's (1986, p. 19) quotation above—will often be found in the research literature. However, such problems should be regarded as means for selecting particular research fields, not as research problems.

As for the proposed definition of applied research, the following three points should be added: (1) The focus in such a research study is on the specified professional/practical context, here termed *practice*. Need analyses suggest which information is required in practice. This needed information may be causal, descriptive, or a combination of both kinds. The analyses will typically be related—directly or indirectly—to some social problems in practice, and will point at some programs for solving such problems, where each program may lead to alternative, possible consequences. (2) A simple or complex research problem is formulated in line with the needed information in practice and general aim. This problem is ordinarily related to a set of possible conclusions with more than two categories, because a dichotomous classification will be too coarse in most instances. To solve the research problem is to provide the needed information, which is obtained by generalization of results from study and knowledge space. Study and knowledge space are therefore subordinate means for providing the information. (3) To strengthen the validity of this generalization to practice, the study should be planned and implemented as similar to practice as possible with respect to constructs of actual factors, variables, persons, and setting. However, this general similarity between study and practice will seldom or never be perfect in empirical cases, due to implementation difficulties (Kazdin, 1978; Shadish et al., 2002). Some poststudy respecification of constructs is therefore almost inevitable (Shadish et al., 2002). But such a construct respecification implies that some constructs in study differ from their respective original constructs, that the research problem in study differs from the original research problem related to practice, and that the solution of the research problem in study is not sufficient for providing the needed information. Hence, in the generalization to practice, the study results may need extra support from knowledge-space information. The validity of this generalization will increase with better methodological quality in study, with higher relevance and validity of the knowledge-space information, and with greater general similarity between study and practice.

The examples of applied research in the first subsection above represent simple research, but a similar reasoning holds also for complex applied research. The following illustrations of applied complex studies may be clarifying.

Suppose that our original therapy study is extended by adding the effect variables of self-esteem and conflict level to alcohol drinking. The research problem will be correspondingly extended.

Suppose further that the therapy has a moderate positive effect on alcohol drinking, a small positive effect on self-esteem, and no effect on conflict level. The conceptualization and evaluation of this applied complex study are the same as for the original therapy study, apart from that we now have three sets of possible solutions, i.e., one set for each effect variable. Added hypotheses and their testing will be unjustified.

Suppose as another illustration, that some need analysis for a specified population indicates a need for studying the effects of food habits and training on health in this population. The general aim in an investigation is therefore to provide such knowledge. One complex research problem is: "Will food habits, physical training, and their interaction have impacts—and to which extent—on general physical health for persons in the population in their daily-life settings?" Each person in a large sample from the population is measured in a survey about food habits, training, and health. A model of simultaneous multiple regression is used for data analysis, where physical health is the dependent variable, where food habits, training, and interaction are the independent variables, and where control variables are included (Cohen et al., 2003). The final conclusion is that the causal effect of food habits is high and much greater than the effect of training, whereas the interaction effect is trivial. The conceptualization of this applied complex study will be analogous to the complex study above. For instance, we have three sets of possible solutions, i.e., one set for each causal variable, and added hypotheses are unjustified.

The multiple regression model in the second complex example above may be considered somewhat weak for claiming causal inferences. A more advanced—and more demanding—model could be used instead, e.g., some variant of structural equation model (Cohen et al., 2003; Shadish et al., 2002), for solving the given research problem. An advanced model might also be relevant for a more comprehensive research problem which included more causal and effect variables. However, such advanced research studies can be conceptualized and evaluated as before with respect to the main issues discussed, e.g., concerning added hypotheses. Finally, the original simple therapy problem—and the first complex study above—might be better answered by using such an advanced model, but the conceptualization concerning the main issues will be the same.

The preceding reasoning about the roles and importance of research problems and hypotheses in educational and psychological research is not restricted to the examples used, but can be applied in general. The main conclusion is therefore—given the proposed definitions of basic/general and applied research as well as the above-mentioned limitations of the present account—that (1) in basic/general hypothesis-testing research, a research hypothesis is sufficient, while a research problem is unjustified, and (2) in applied research, a research problem is sufficient, whereas a research hypothesis is unjustified. Hence, in each kind of research, either a hypothesis or a problem is needed, but not both. It follows, in particular, that Kerlinger's (1986) assertions that a research study should include both a problem and a hypothesis, and that a problem cannot be scientifically solved without reduction to hypothesis form, are not correct.

The account above shows the importance of general aim and need analysis. For example, although the hypothesis in the extended therapy study satisfies the four criteria for hypothesis choice, this hypothesis is unjustified, due to the stated general aim. As another example, suppose that we regard the validity of the final conclusion in the original therapy study as being somewhat unsatisfactory due to methodological weaknesses, and that we therefore replicate the study, but now with better methodology. Could we use the final conclusion in the original study as a research hypothesis in the second study? Certainly not, because the general aim in the original study is relevant also for the second study. Hence, also in the second study, a research problem is justified, while a hypothesis is not.

One argument against the account in this paper might be that problem solving is defined too closely to hypothesis testing, so that it becomes, in fact, a kind of implicit hypothesis testing. This argument is incorrect, due to the following points: (1) A problem is a question, whereas a hypothesis is a kind of knowledge claim. Hence, the validity concept applies to a hypothesis, not to a problem. (2) A problem is broader and more open than a hypothesis in the sense that a problem encompasses a set of possible final result conclusions, whereas a hypothesis is a prediction of—is related to—one possible result conclusion. (3) A hypothesis, but not a problem, can be tested. A hypothesis is tested by testing its validity, while a problem is solved by trying to find the best candidate in its solution set. (4) The solving of a problem and the testing of hypothesis are related to two different views on knowledge, i.e., knowledge taken for granted and knowledge on trial, respectively. (5) In the case where an applied study does not include a ps_{max}, a hypothesis will not only be in conflict with general aim, but will also violate the initial-validity criterion. A problem will still apply, but its validity depends only on methodological quality, not on knowledge-space information.

The account in this paper is limited to some important issues concerning research problems and hypotheses in individual, substantive, empirical, and quantitative research studies. How research problems/hypotheses are involved in other central research strategies is therefore omitted here, e.g., in comprehensive programs or series of studies in quantitative research, in qualitative research, in mixed-method research (Teddlie & Tashakkori, 2003), in meta-analytic research (Shadish et al., 2002), and in methodological research.

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